JSCE AWARD 2022

Award Winners from the Concrete Engineering Field

Selection Policy for various JSCE Awards

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List of Award Winners

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- Dr. Hiroshi Yokota (CDIT, Hokkaido University)
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[Bridge Design and Construction]

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- Yodogawa Bridge

Innovative Technique Award

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- Dr. Junichi Matsumoto (TAISEI CORPORATION) et al.
- Dr. Hiroki Ogura (SHIMIZU CORPORATION) et al.

Selection Policy for various JSCE Awards

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Achievement Award

Achievement Award is given to members who have made outstanding contributions to the advancement of civil engineering, the development of civil engineering projects, and the administration of JSCE.

Technical Award

Technical Award is given to members who have made significant contributions to the development of civil engineering technology in the areas of planning, design, and construction of civil engineering projects.

Environmental Award

Environmental Award is given to epoch-making achievements in the development and operation of civil engineering technologies and systems that reduce the burden on the environment and contribute to the preservation of a good environment and the creation of a more affluent environment, as well as to epoch-making projects that contribute to the preservation of the environment and creation of an environment in which humans and nature can coexist.

- In Group I, selection will be made for advanced civil engineering research that has contributed to the development of new technologies, concept formation, theory building, etc., that contribute to the conservation, improvement, and creation of an environment in which humans and nature can coexist.
- In Group II, the selection is based on groundbreaking projects that have contributed to the conservation and creation of an environment in which humans and nature can coexist through the development and operation of civil engineering technologies and systems.

Research Achievement Award

Research Achievement Award is given to individuals who have made outstanding contributions to the advancement and systematization of science and technology in civil engineering through a series of papers and other achievements in research, planning, design, construction, engineering design, or maintenance management.

Research Paper Award

Research Paper Award is given to the author of a paper on research, planning, design, construction, engineering design, or maintenance management that has made a significant contribution to the advancement and systematization of civil engineering science and technology.

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Incentive Paper Award

Incentive Paper Award is given to a person under 40 years of age who has made a major contribution to the advancement and development of science and technology in civil engineering and is recognized as highly original and promising in his or her research, planning, design, construction, engineering design, or maintenance management papers published in the field of civil engineering.

Yoshida Award

Yoshida Award was established to commemorate the achievements of the late Dr. Tokujiro Yoshida.

- In the Research Achievement Category, those who are recognized as having made significant achievements in the advancement and development of technology related to concrete are eligible for selection.
- In the Research Paper Category, the award is given to a single paper or report on concrete published in a JSCE publication that has made a significant contribution to the development of concrete engineering.
- In the Research Encouragement Category, the recipients of the award are those who are engaged in research related to concrete engineering, are under 40 years of age and who are recognized as having particular originality and potential.

Tanaka Award

Tanaka Award was established to commemorate the achievements of the late Dr. Yutaka Tanaka.

- In the Achievement Category, those who are recognized as having made outstanding achievements in the advancement and development of bridge engineering are eligible for selection.
- In the Research Paper Category, papers that have made a significant contribution to the development of bridge engineering are eligible for selection.
- In Bridge Design and Construction Category, papers that have made a significant contribution to the development of bridge engineering are selected.
- In the Technical Category, excellent or innovative technologies applied to bridges or similar structures that are unique in terms of planning, design, fabrication/construction, maintenance, renewal, rehabilitation, demolition, and removal are eligible for selection.

Innovative Technique Award

Innovative Technique Award is given to individuals or teams that have developed and put into practical use technologies that are recognized as highly original and ingenious in planning, design, construction, or maintenance, and that have contributed to society through the development of civil engineering technology.

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Publication Culture Award

Publication Culture Award is given to "the author of a publication related to civil engineering that contributes to the development of civil engineering or civil technology, or is recognized as being part of civil engineering cultural activities by impressing readers".

International Lifetime Contribution Award

International Lifetime Contribution Award is given to individuals who have contributed to the progress and development of civil engineering or social infrastructure development in the international community, including Japan, through exchange and cooperation between Japan and other countries, and whose activities have been highly evaluated.

International Outstanding Collaboration Award

International Outstanding Collaboration Award is given to individuals under 50 years of age who have contributed to the progress and development of civil engineering or the improvement of social infrastructure in Japan and other countries through exchange and cooperation between Japan and other countries, and who are expected to continue to make significant contributions in the future.

Technical Achievement Award

The Technical Achievement Award is "awarded to those who for many years have made diligent contributions to the advancement of civil engineering or the development of civil engineering projects." People in the following fields are eligible for selection.

(1) Education, research, and awareness-raising
(2) Research and planning
(3) Design and supervision
(4) Site and compensation
(5) Construction and inspection
(6) Management, operation, disaster prevention and conservation

Achievement Award

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Dr. Masayasu Otsu

Advisor, Consortium of Innovative Technique for Infrastructure, Kyoto University Graduate School and Board Chairman, Advanced Technology Institute of Infra-Maintenance (ATIM)

Reasons for the Award

Dr. Masayasu Otsu has achieved remarkable results in his research on acoustic emission (AE) to elucidate the cracking mechanism and fracture process of concrete and to establish inspection methods. He is the author of "Characteristics and Theory of AE," the first textbook on AE in Japan, and has published three volumes of technical papers on AE and nondestructive testing of concrete outside Japan, which are highly regarded internationally. As Chairman of the Research Committee of the International Union of Testing and Research Institutes for Materials and Structures (RILEM), he promoted international joint research and helped establish three ISO standards, the first in the world, for AE testing methods for concrete materials. In this way, he contributed to the advancement of civil engineering worldwide by establishing nondestructive testing methods for the evaluation of defects in concrete materials.

In JSCE, he served as a subcommittee chairman of the Structural Mechanics Committee and the Structural Engineering Committee, and as a standing member of the Concrete Committee, he contributed to the enhancement and advancement of the research division. Furthermore, he contributed to the management of the Western Branch of JSCE as Branch Director.

For these reasons, he was recognized as a worthy recipient of the Achievement Award.

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Dr. Hirotaka Kawano

Visiting Professor, Graduate School of Management, Kyoto University

Reasons for the Award

Dr. Hirotaka Kawano has made significant contributions to the deployment of technology to society, the training and guidance of engineers, and the operation and development of the Japan Society of Civil Engineers through research, technical guidance, standardization, and society committee activities related to concrete. During his tenure at the Public Works Research Institute, he worked on durability issues of concrete structures, such as salt damage and alkali-silica reaction, and concrete construction quality issues, and participated in the preparation of notices by the Ministry of Land, Infrastructure, Transport and Tourism.

At JSCE, he participated in the JSCE Concrete Committee for many years, contributing to the revision of the Standard Specifications for Concrete and the establishment of various guidelines for concrete materials and structures. In particular, as the vice-chairman of the construction section of the 2007 edition of the specifications and as the chairperson of the construction section of the 2012 edition of the specifications, he promoted the reorganization of the construction section of the specifications into performance specifications and the system that continues to the present day. In the Kansai Branch of the Japan Society of Civil Engineers (JSCE), he has made efforts to ensure the proper implementation of the Quality Assurance Act and to substantiate the Act.

For these reasons, he was recognized as a worthy recipient of the Achievement Award.

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Dr. Tsutomu Fukute

Emeritus Professor, Toyo University and Visiting Researcher, Specialists Center of Port and Airport Engineering (SCOPE)

Reasons for the Award

Dr. Tsutomu Fukute has made significant achievements in the pavement field for airport construction, developing technologies that can be widely deployed in the field, such as pavement technology on soft ground, and creating design standards, the effectiveness of which have been highly evaluated in the subsequent construction of airports. In the interdisciplinary field, he has focused on the importance of maintenance engineering in future social infrastructure, and has conducted research on asset management of infrastructure, while also working to train future leaders who will support future social infrastructure.

In JSCE, he has participated in the Concrete Committee, the Engineer Qualification Committee, and the Engineer Education Program Review Committee, etc. In the Engineer Qualification Committee, he has been involved in the committee for many years, contributing to the steady operation and spread of the technical qualification system. He has also been involved in disseminating information on the role of civil engineering and its social importance to a wide range of people by supervising the publication of books on civil engineering knowledge for upper elementary school students and older, and was awarded the Publication Culture Award by the Japan Society of Civil Engineers in 2020 for this achievement.

For these reasons, he was recognized as a worthy recipient of the Achievement Award.

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Dr. Hiroshi Mutsuyoshi

Emeritus Professor and Visiting Professor, Saitama University and Visiting Professor, Dalian University of Technology

Reasons for the Award

Dr. Hiroshi Mutsuyoshi has made many achievements in the fields of earthquake resistance of concrete structures, prestressed concrete, new materials, and bridge engineering, and has published many papers in JSCE Transactions and other overseas English journals. These results have been incorporated into the Standard Specifications for Concrete and other standards.

In terms of education, he has established a special English course for foreign students in the graduate school of construction at Saitama University, and has produced many master's and doctoral students.

In international activities, he has received the "Educational Contribution Award" from the Ministry of Education of Vietnam. He is a Fellow of the American Concrete Institute (ACI). He is a Fellow of the American Concrete Institute (ACI).

He has made significant contributions to the JSCE Concrete Committee and the Subcommittee on Revision of Concrete Specifications. Furthermore, he has made significant contributions to the development of JSCE by serving as the chairman of the Structural Engineering Steering Subcommittee, the chairman of the Structural Engineering Committee, and the chairman of the Tanaka Award Selection Committee.

For these reasons, he was recognized as a worthy recipient of the Achievement Award.

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Dr. Hiroshi Yokota

Counselor, Coastal Development Institute of Technology (CDIT) and Emeritus Professor, Hokkaido University

Reasons for the Award

Dr. Hiroshi Yokota has promoted research on the advancement of design and maintenance of concrete and composite structures, as well as technological development and its implementation, and has made outstanding achievements, especially in establishing and systematically developing a framework for life cycle management from design to maintenance of infrastructures.

In international activities, he served as a director and president of the Asian Concrete Federation, and contributed greatly to the development of civil engineering in the Asian region through the establishment of the Asian Concrete Model Code. He also led the establishment of ISO standards for the life cycle management of concrete structures, contributing greatly to the enhancement of Japan's international presence.

In the Japan Society of Civil Engineers (JSCE), his contributions to the specifications and guidelines of the Structural Systems Committee, especially to the establishment of the Standard Specifications for Composite Structures, which he established as chairman of the Composite Structures Committee, and to the revision of the Standard Specifications for Concrete Structures are very significant.

For these reasons, he was recognized as a worthy recipient of the Achievement Award.

Technical Award (Group I)

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Large-Scale Precast Construction of Civil Engineering Structures that Contributed to the Early Operation of a Thermal Power Plant

JERA Power TAKETOYO LLC., JERA Co., Inc., TAISEI CORPORATION

Reasons for the Award

The replacement project of Taketoyo Thermal Power Station involved the decommissioning and removal of the existing petroleum-fueled power generation facilities and the construction of a new 1.07 MW-class, high-efficiency power generation facility (Unit 5) that mixes coal and woody biomass fuel for the purpose of ensuring a stable supply of electricity to the region. The civil works consisted of offshore construction to build a new foundation for a coal unloading pier, a loading/unloading pier for receiving fuel and carrying out coal ash, and conveyor facilities for receiving and discharging coal, and onshore construction to build a new water intake and discharge facility, a frame structure for the foundation of various onshore facilities, and a set of other exterior facilities on the premises. The project is characterized by the use of large-scale precast construction (PCa) to shorten the construction process and ensure quality, in order to facilitate the early operation of the power plant.

For the coal hoisting pier and offshore conveyor foundations, PCa construction was achieved with a diagonal pile structure by developing temporary materials such as steel support members and scaffolding for PCa members, and for the offshore passage bridge, an unprecedented PC girder concrete bridge was erected all at once. In the construction of the spillway, we realized a large-scale and innovative construction using PC-walls for the first time in Japan by developing a design and new materials to realize a structural form, leakage prevention, and flexible structure as a method of constructing a waterway that can cope with large-scale earthquakes. Furthermore, fly ash was effectively utilized as a concrete mixing material, contributing to the reduction of environmental impact.

This achievement was highly evaluated as a technology that can contribute to the improvement of productivity in similar works in the future, and was recognized as worthy of the Technical Award.

Technical Award (Group I)

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Shinkansen's First Open-Bed PRC Langer Bridge Lifted Overhead for Early Completion of River Improvements

East Japan Railway Company Tohoku Area Construction Project Management Office,
Akita Prefecture, JR East Consultants Company Tohoku Branch,
TEKKEN CORPORATION Tohoku Branch, DAIICHI KENSETSU Co., LTD. Akita Branch

Reasons for the Award

The large-scale flooding of the Kinai River affected the Akita Shinkansen line between Kakunodate and Omagari and triggered the urgent need for a new bridge to replace the old bridge over the Kinai River. In designing the new bridge and planning its replacement, it was necessary to satisfy both the requirements for a railroad bridge, such as maintenance and management and track alignment, and the requirements for river disaster prevention, such as reduction of the river load-barrier ratio.

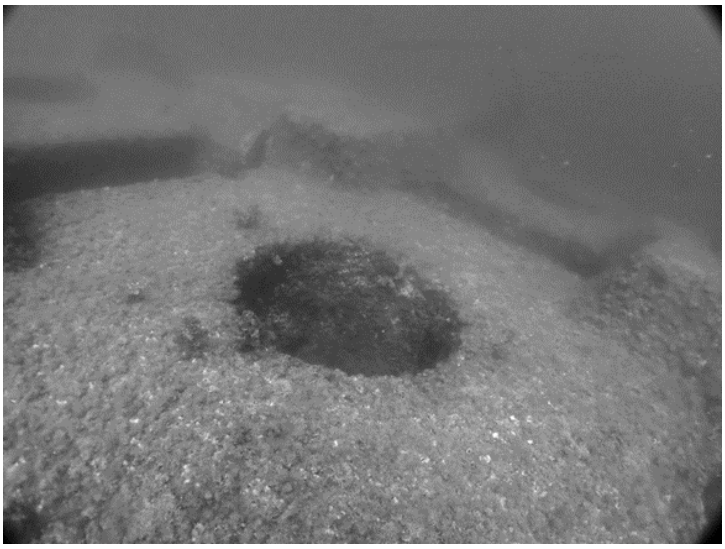
Therefore, the new bridge structure was a single-diameter open-deck PRC langar girder without intermediate piers (bridge length: 71.1 m, weight: 1,500 tons), which was designed in consideration of river disaster prevention and snow accumulation in the bridge structure. Since the open-floor PRC langar girder was the first structure of its kind to be used by East Japan Railway Company, the behavior of the girder, such as torsion, was confirmed in advance using FEM analysis. In order to shorten the construction period as much as possible, the first active line laying method was adopted in the Shinkansen line section for the replacement of the new bridge. In order to minimize the impact on Shinkansen transportation, various measures were taken, such as installing a newly developed construction girder on the back of the old abutment and excavating fill in advance, to shorten the work time and reduce construction risks on the night of the switchover. As a result, the number of train cancellations on the night of the bridge replacement could be reduced to four, and the bridge replacement, including work on the track and electrical equipment, was completed in 8 hours and 55 minutes.

The various technologies that achieved both river disaster prevention and safe and stable train transportation were highly evaluated for their outstanding contribution to the development of civil engineering technology and to the development of society, and were recognized as worthy of the Technical Award.

Port Development Considering Biological Symbiosis at Suzaki Port, Kochi Prefecture

Sanyo Techno Marine, Waterfront Vitalization and Environment Research Foundation (WAVE),
Minis-try of Land, Infrastructure, Transport and Tourism Shikoku Regional Development Bureau

Reasons for the Award



The Port of Susaki in Kochi Prefecture, the site of this project, is a good natural harbor, but it is also vulnerable to tsunamis, and has suffered major tsunami damage on numerous occasions in the past. The Great East Japan Earthquake led to improvement work that created a shallow area by reinforcing the breakwater's girders, increasing the strength of the breakwater, and creating a 0.2 ha seaweed bed in the shallow area created at the base of the breakwater through a seaweed bed creation demonstration test conducted from FY 2014 to FY 2021. Since most of the reef areas in and around Suzaki Port are in a state of rocky scorch with no seaweed beds, the created seaweed beds not only play an important role as a habitat for organisms, but also function as a blue carbon ecosystem and are estimated to fix 1.3 tons of CO_2 per year, contributing to the realization of a carbon-neutral port. In the breakwater, a seaweed-planting test was conducted to effectively utilize the recycled steel slag hydrate solidified by hydration. The steel slag was found to be effective in sorption of southern species of Hondawara and Tengusa, and the results showed that the slag is expected to be used as a covering block from the viewpoint of low-carbon-type structures.

As described above, the successful creation of seaweed beds at the breakwater abutment, the effective use of recycled steel slag in port and harbor development, and the detailed monitoring during the eight-year-long demonstration test of seaweed bed creation were judged to be worthy of the Environmental Award.

Comprehensive Study on the Correlation Between Space Size and Mass Transfer/Flow Properties in Concrete

Toshiharu Kishi
The University of Tokyo

Reasons for the Award

In order to further improve the quality of concrete in actual structures, it is necessary to clarify the microscopic mechanisms governing the material behavior of concrete based on deep insight. Dr. Toshiharu Kishi has been conducting original research on all aspects of material properties of concrete, and this work in particular is representative of his efforts.

In his research on fresh concrete, he showed that the space size between cement particles governs the flowability, and he proposed the need for a constitutive law that takes into account the "non-flowing water" in the microscopic space. This knowledge was further developed into research on mass transfer phenomena in hardened concrete, and it was clarified that in concrete with a dense pore structure and appropriate use of admixtures, the penetration of liquid water stagnates near the surface layer, and that the penetration of chloride ions also stagnates, and a theory was developed. Furthermore, it was experimentally clarified that the resistance to various forms of mass transfer can be uniformly evaluated by the smallest void diameter, which is the bottleneck of the mass transfer pathway. All of these results are constitutive rules, and the parameters necessary for input were selected from those obtained from practical work, skillfully balancing logical knowledge and practicality, and the impact on the development of this research field has been significant.

In this way, he has a highly regarded track record in both academic research and engineering practice, and his outstanding contributions to the advancement and systematization of science and technology in civil engineering make him a worthy recipient of the Research Achievement Award.

Research Paper Award

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PRESTRESS INTRODUCTION TECHNOLOGY USING PC STEEL STRANDS EXTENDING FROM PRE-TENSIONED MEMBERS

Journal of Japan Society of Civil Engineers, Ser. E2 (Materials and Concrete Structures), Vol. 78, No. 1, pp. 72-89, 2022. (Access to this paper)

Kimihiko Amaya
NIPPON P.S CO., LTD.

Takaya Tsunoda
NIPPON P.S CO., LTD.

Satoshi Takaya
Kyoto University

Takashi Yamamoto
Kyoto University

Reasons for the Award

In order to expand the range of application of the precast method, the authors of this paper are developing a hybrid PC structure (hereinafter referred to as "HPC structure") in which PC steel members extended from pre-tensioned members are re-tensioned and prestressing is introduced to the connecting members in a post-tensioning method to integrate them. The HPC structure assumes the use of 1S15.7 high-strength PC steel strand (hereinafter referred to as "UHSP"), which can introduce high prestressing force, but there has been no experience in the application of UHSP to pretensioned structures. Therefore, the present paper describes the adhesion properties of PC steel strands during prestressing and re-tensioning.

In this paper, we experimentally investigated the strain behavior of PC steel strands during prestressing and re-tensioning, and showed that the combination of UHSP and high-strength concrete of 70 N/mm^2 or higher can ensure the adhesion strength required for prestressing and estimate the amount of extraction of the PC steel strands during re-tensioning, thereby realizing an HPC structure. The results showed that the HPC structure could be realized by combining the high-strength concrete with a minimum of N/mm^2. Furthermore, the adhesion stress-slip volume relationship formulated based on the experimental results was implemented in a nonlinear FEM analysis to study the reproducibility of the prestressing condition of the HPC structure.

As described above, this paper shows the feasibility of the HPC structure and the results of a new model that takes into account the adhesion properties of the PC steel strands, and is expected to contribute to the advancement of analysis methods for PC structures.

Incentive Paper Award

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EXPERIMENTAL ELUCIDATION OF SHEAR FATIGUE FAILURE MECHANISM OF RC BEAM WITHOUT STIRRUPS

Journal of Japan Society of Civil Engineers, Ser. E2 (Materials and Concrete Structures), Vol. 78, No. 1, pp. 30-45, 2022. (Access to this paper)

Kyoko Takeda
Oriental Shiraishi Corporation

Reasons for the Award

RC slabs subjected to cyclic moving wheel loads become sheared by cracks that start in the direction perpendicular to the bridge axis and then penetrate vertically. The shear failure mechanism of this structure is essential for fatigue life evaluation of RC slabs because the sheared area can be regarded as an RC structure without shear reinforcement.

This paper discusses the shear damage and failure mechanisms of RC slabs without shear reinforcement, based on a detailed understanding of the deformation behavior using the sampling moiré method. The results of the paper have the potential to contribute to the development of a new fatigue life prediction method for reinforced concrete slabs and to the development of structural forms with superior fatigue resistance.

Yoshida Award
Research Achievement Category

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Research on Quality Improvement of Concrete Structures Focusing on Workability

Kimitaka Uji
Tokyo Metropolitan University

Reasons for the Award

During his time in the private sector and his research activities at universities, the awardee has consistently conducted research related to concrete materials, construction, and the structural properties of new materials.

Focusing on the compaction of fresh concrete, he presented an original approach to evaluating compaction from the viewpoint of compaction energy. This is a quantitative evaluation method that replaces the previous qualitative and empirical evaluations. The award also presents a simple and appropriate approach for evaluating deformability and resistance to material separation by quantitatively evaluating tamping as energy imparted to concrete, which will greatly contribute to ensuring the quality and durability of structures. In addition, the awardee contributed to the effective use of resources by preparing design and construction guidelines for the application of copper slag fine aggregate and other materials to concrete as the chairman of the Research Subcommittee on Nonferrous Slag Aggregate Concrete. In the work to revise the 2007, 2013, and 2023 editions of the Standard Specifications for Concrete, he served as the chief of the Dam Concrete Section Subcommittee and made significant contributions to the development of construction technology for dams by reviewing the specifications to ensure quality and improve durability of concrete dam embankments, streamline construction, and promote the use of new technologies.

The above-mentioned efforts by the awardee to achieve high-quality and durable concrete structures have greatly contributed to the progress and development of technologies related to concrete engineering, and are recognized as worthy of the Yoshida Award in Research Achievement Category.

Yoshida Award
Research Achievement Category

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Development of a Multi-Scale Integrated Analysis System for Cementitious Composites and Macroscopic Structural Response

Koichi Maekawa
Yokohama National University

Reasons for the Award

Since the mid-1990s, Dr. Koichi Maekawa has advocated the importance of knowledge structuring that integrates materials science and structural engineering and the potential of multiscale coupled analysis through his publications in English and other media, and has led the research trend since the emergence of the subject. He has demonstrated a high degree of originality in his research, which ranges from the nano-level microstructure of materials to the response of social infrastructure structures on the kilometer scale, and has led the field both domestically and internationally.

Based on this systematic knowledge, the Institute has developed a highly versatile and expandable research foundation, which is highly appreciated. Research has been conducted not only on the coupling of heat and water and the advection and diffusion of chloride ions, which have long been central issues in concrete engineering, but also on the dissolution of calcium ions and the evaluation of concrete storage facilities and cement improved ground over a very long period of time. In recent years, multi-scale models have been implemented one after another and outstanding research results have been continuously obtained, such as hydrate loss and recrystallization during high-temperature fires, and extension to porous polomechanics under the action of freezing and thawing.

Furthermore, the award is also highly regarded in terms of practical applications to the design and maintenance of real structures, such as the problem of excessive deflection of large bridges, deck fatigue under moving loads, and the evaluation of the seismic resistance of seismic components subjected to steel corrosion.

As described above, the recipient of the Yoshida Award is recognized as having made outstanding achievements in the advancement and development of technology related to concrete engineering, and is therefore deemed worthy of the Yoshida Award in Research Achievement Category.

Yoshida Award
Research Paper Category

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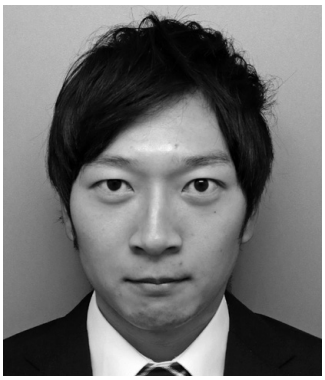
ANALYTICAL STUDY ON THE POST-CONSTRUCTION SHEAR STRENGTHENING EFFECT OF RC MEMBERS USING 3-DIMENSIONAL RBSM

Journal of Japan Society of Civil Engineers, Ser. E2 (Materials and Concrete Structures), Vol. 78, No. 2, pp. 179-196, 2022. (Access to this paper)

Keisuke Kawamura
TAISEI CORPORATION

Hikaru Nakamura
Nagoya University



Masashi Takemura
Nagoya University

Taito Miura
Nagoya University

Reasons for the Award

In the past, research on seismic reinforcement methods using post-insertion of shear reinforcement bars (hereinafter referred to as "PHBs") with anchorage bodies at both ends has focused on macroscopic behavior such as bearing capacity through experiments and analysis. The challenge has been to clarify information on shear cracks that occur in RC members with PHBs and the mechanism of the reinforcement effect of PHBs for a wide variety of structural parameters.

In this paper, an analytical study using a three-dimensional rigid-body spring model that can represent crack propagation is conducted, and the relationship between the width, height, and shear span ratio of the cross-section and the shear reinforcement effect of PHBs and the shear resistance mechanism of RC members is clarified for the first time. For the shear reinforcement effect, it was shown that the narrower the spacing of PHBs in the width direction, the smaller the shear crack width in the cross-section, and the greater the reinforcement effect. For the shear resistance mechanism, it was shown that when the displacement spreading in the width direction is uniformly restrained, the shear force borne by the concrete arch mechanism is maintained and the shear force borne by the truss mechanism with PHBs increases, resulting in a significant increase in shear capacity.

These findings not only lead to a proposal for a more effective arrangement of PHBs, but are also useful in rearranging the shear failure behavior of newly constructed structures in three dimensions, and are expected to be reflected in future improvements and greater precision in design systems related to shear resistance of RC members.

For these reasons, this paper is deemed worthy of the Yoshida Award in Research Paper Category.

Yoshida Award
Research Paper Category

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PREDICTION OF LONGITUDINAL CRACKS AND EVALUATION OF LOAD CARRYING CAPACITY FOR PC GIRDERS USING MULTI-SCALE ANALYSIS

Journal of Japan Society of Civil Engineers, Ser. E2 (Materials and Concrete Structures), Vol. 78, No. 1, pp. 13-29, 2022. (Access to this paper)


Satoshi Tsuchiya
COMS Engineering Corporation


Tadatomo Watanabe
Hokubu Consultant Co., LTD


Shigehiko Saito
University of Yamanashi


Takeshi Maki
Saitama University


Tetsuya Ishida
The University of Tokyo

Reasons for the Award

After some time in service, pretensioned PC hollow slab girders often develop axial cracks along the steel members. It has been presumed that these cracks are caused by steel rusting, ASR, insufficient cover, and other factors. In this paper, we have elucidated the possibility that cracks may become apparent after several decades due to seasonal variations in temperature and humidity alone, even when standard materials are used and careful curing, construction, and appropriate management are performed, through a multiscale integrated analysis that couples the interaction between the aging of the constituent materials and the structural response. Although no cracking occurs immediately after in-service, the combined effects of prestress and environmental effects, coupled with long-term hydration evolution, are shown to be the cause of cracking. Furthermore, the static load-bearing capacity of the actual structure at approximately 50 years after in-service was traced, and it was confirmed that the effect of cracking on the load-bearing capacity was small.

The results of this research are expected to be utilized for maintenance management based on preventive maintenance, such as reviewing the cross-sectional shape of girders and the arrangement of steel members. The study also points out the importance of not only taking symptomatic measures when deformation is found in an existing structure, but also tracking changes over time from the time of construction, clarifying the mechanism of occurrence, and formulating countermeasures based on the functions and performance required of the structure. The paper presents an actual example of digital twin and discusses its significance and potential, and its wide-ranging development potential for the future is recognized.

For these reasons, this paper is deemed worthy of the Yoshida Award in Research Paper Category.

Yoshida Award
Research Encouragement Category

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Development of High Performance Self-Healing Concrete Using Aerobic Microorganisms and SHIRASU

Kentaro Koike (Kagoshima University)

Research on performance evaluation method by numerical analysis for corroded and deteriorated PC structures

Ryota Kurihara (The University of Tokyo)

Tanaka Award
Research Paper Category

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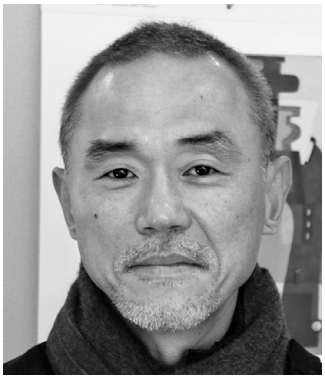
NUMERICAL SIMULATION OF RUPTURE AND PROTRUSION OF VERTICALLY TIGHTENED PC BARS IN PC GIRDERS WITH ASPHALT PAVEMENT USING APPLIED ELEMENT METHOD

Journal of JSCE, Vol. 10, pp. 145-161, 2022. (Access to this paper)

Addisu Desalegne BONGER
Yokohama National University



Akira Hosoda

Yokohama National University

Hamed SALEM

Cairo University

Takayuki Fukaya

Metropolitan Expressway Company Limited

Reasons for the Award

This paper examines the effect of two layers of asphalt pavement preventing the top surface of vertical PC steel bars placed on the web of a road bridge PC box girder from rupture protrusion by means of a full-scale experiment of rupture protrusion and a detailed analysis of the rupture process by simulating the high-speed rupture phenomenon with the applied element method. This paper is a detailed analysis of the fracture process. The usefulness and practicality of this paper lies in the fact that the stiffness of a PC steel bar moving at high speed in contact with a sheath, the effect of strain rate on the strength properties of asphalt, and other factors were appropriately modeled to achieve high accuracy in the applied element method simulation. The high accuracy achieved by the authors made it possible to reproduce in numerical simulation the effect of two layers of 80 mm asphalt to protect against fracture protrusion. The simulation technology developed can reproduce the situation of PC steel bar protrusion, residual deformation and delamination of asphalt, and succeeded in analyzing the high-speed fracture process in detail. It is highly expected that this technology can be used to effectively and economically design and verify the performance of a large number of existing vertical PC steel bars to prevent them from rupturing and protruding.

Based on the above, this paper is considered to be worthy of the Tanaka Award because of its substantial contribution to the strengthening of bridge infrastructure and its significant contribution to the progress and development of science and technology in bridge engineering.

Tanaka Award
Bridge Design and Construction Category

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Yoshino River Sunrise Bridge

Contractee	West Nippon Expressway Company Limited
Designer	KAJIMA CORPORATION, Sumitomo Mitsui Construction Co., Ltd., JV of TOYO CONSTRUCTION CO., LTD., Eight-Japan Engineering Consultants Inc.
Constructor	KAJIMA CORPORATION, Sumitomo Mitsui Construction Co., Ltd., JV of TOYO CONSTRUCTION CO., LTD.

Reasons for the Award

The bridge is one of the longest road bridges in Japan, a 15-diameter PC continuous box girder bridge (length: 1,696.5 m), and was constructed at the mouth of the Yoshino River, a Class 1 river with a rich natural environment. The upper structure was designed as a girder bridge so as not to disturb migratory birds flying to the tidal flats located upstream of the bridge. In addition, fly ash was used as an admixture in the upper structure to improve densification due to the salt-affected environment.

The balanced cantilever method using precast segments was adopted to conserve the environment (benthic organisms) around the site and to reduce the amount of dredging by combining erection of girders and tension erection using erection noses.

In order to improve seismic resistance and maintenance management, the upper and lower sections of the six piers in the center of the bridge were rigidly connected, and the largest horizontal force method in Japan was used when the rigidly connected sections were closed to reduce the stress generated at the base of the substructure due to creep of the upper structure and to establish the structure. Precast drainage gutters were used for bridge drainage instead of conventional drainage pipes to achieve a highly durable structure. The precast drainage gutters also serve as inspection channels to improve maintenance and management, and the drainage system is integrated with the girders for improved landscaping. Furthermore, as part of the maintenance system for this bridge, which is difficult to inspect because it is an in-river structure, a tension force measurement system using PC outer cables with optical fibers was adopted.

The above efforts were considered to be worthy of the Tanaka Award because of their potential contribution to future bridge construction.

Tanaka Award
Bridge Design and Construction Category

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Large-Scale Renewal of the Yodogawa Bridge

Contractee	Ministry of Land, Infrastructure, Transport and Tourism Kinki Regional Development Bureau
Designer	Eight-Japan Engineering Consultants Inc., IHI Infrastructure Systems Co., Ltd., JV of Yokogawa NS Engineering Corp.
Constructor	IHI Infrastructure Systems Co., Ltd., JV of Yokogawa NS Engineering Corp.

Reasons for the Award

The Yodogawa Bridge, National Route 2, crosses the Yodogawa River that flows through the Osaka Plain. The bridge was completed in 1926, and this year marks its 96th anniversary, despite having been hit by air raids during wartime and major earthquakes during peacetime. Traffic volume is approximately 35,000 vehicles/day, making it an important arterial road between Osaka and Kobe. The bridge is 724.5 m long, and the superstructure consists of a 6-diameter steel simple upper road warren truss bridge in the center span and 12-diameter steel simple plate girder bridges in both spans, with RC slabs.

The bridge had deteriorated in terms of load-bearing capacity due to significant damage from concrete delamination, exposed rebar, water leakage, and corrosion of steel members, so a large-scale renewal project was carried out, mainly by replacing the floor slabs. The required seismic capacity was secured without direct reinforcement of the piers and foundation. In addition to replacing the slabs, more than 1,100 corroded steel members were repaired.

Because the bridge is an important arterial road, the entire bridge was divided into three phases in the direction of its width, and construction was carried out while maintaining a lane at all times. This was the first project in which the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) applied the ECI contract method. This large-scale renewal has realized the maintenance and improvement of the Yodogawa Bridge's functions, and under appropriate maintenance and management, the bridge will continue to play a major role as a road that supports the economy and lifestyle of the local community for the next 100 years of use.

As described above, this is a large-scale renewal under traffic service on a trunk road with extremely heavy traffic volume, and the work is recognized as worthy of the Tanaka Award because of its contribution to the technological development of large-scale renewal, which will increase in the future.

Innovative Technique Award

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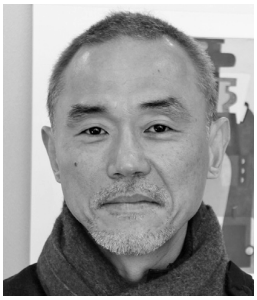
Development of Technology to Ensure Quality of Concrete Structures by Accelerating PDCA Using Data (CONCRETE@i®)


Shuji Yanai
KAJIMA CORPORATION


Kenzo Watanabe
KAJIMA CORPORATION


Shuji Matsumoto
KAJIMA CORPORATION


Kohei Mizuno
KAJIMA CORPORATION


Akira Hosoda
Yokohama National University

Reasons for the Award

In concrete construction work, since fresh concrete is handled whose properties change from moment to moment, if quality control and construction management are neglected, it will lead to construction problems and deterioration of the quality of the structure. Therefore, "appropriate planning and construction based on that planning," "real-time situation monitoring, instantaneous judgment and response," and "PDCA (plan-do-check-act) by looking back" are implemented based on engineers' empirical knowledge.

On the other hand, in recent years, the shapes of members and the arrangement of reinforcing steel have become more complex, and construction conditions have become more diverse. In addition, there are concerns about the aging of skilled workers, the shortage of workers, and the hollowing out of the skills and experience of those in charge at the ordering agency and the prime contractor.

This technology developed this time implements the above-mentioned efforts based on "data." It is a system that assists in the formulation of appropriate construction plans, and "visualizes" the state of concrete and the progress of construction at each stage of the process using ICT tools to manage them with multiple eyes. The system allows anyone to instantly grasp the situation, make appropriate judgments, and take action, thereby ensuring quality without causing problems. In addition, the system scores the workmanship after construction, and PDCA linked to the construction data can be used to improve quality. The experienced knowledge of skilled engineers can be supported by data, and construction methods can be standardized and handed down to the next generation.

This technology is worthy of the Innovative Technique Award because of its potential for future quality and construction management in concrete construction and for the transmission of technology to future generations.

Innovative Technique Award

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Development of High-Strength Environmentally Friendly Concrete with Significantly Reduced CO2 Emissions and Practical Application in the Form of Secondary Products

Junichi Matsumoto
TAISEI CORPORATION

Kenichi Horiguchi
TAISEI CORPORATION

Toshihide Kimura
TAISEI CORPORATION

Satoshi Hashimoto
TAISEI CORPORATION

Fumihiko Sugai
TAISEI CORPORATION

Tatsuya Yamanashi
TAISEI CORPORATION

Shin Sawakami
TAISEI CORPORATION

Reasons for the Award

The award winners have made practical use of secondary products made from high-strength, environmentally friendly concrete that uses "zero" Portland cement and a large amount of blast furnace slag fine powder, a byproduct of steelmaking, toward achieving carbon neutrality by 2050. The company has also demonstrated that the amount of CO_2 emissions associated with the production of concrete materials can be significantly reduced compared to conventional concrete.

Compared to ordinary concrete of the same strength level, high-strength environmentally friendly concrete has the characteristic that the higher the strength expression, the more rapidly the viscosity increases, resulting in a significant decrease in workability, making it difficult to manufacture as a secondary concrete product. However, through long-term research and development, the award winners established a method for selecting a mix that has both the workability and strength development required for secondary concrete products by adjusting the combination of materials used and their amounts. This also established a quality control method that minimizes quality variation among secondary product plants.

The high-strength environmentally friendly concrete secondary products manufactured based on this quality control method were applied to shield tunneling and road construction projects, and their practical use has contributed to lower costs for CO_2 reduction and a large reduction in CO_2 emissions.

In light of the above, this technology contributes greatly to CO_2 reduction in the concrete field, and is worthy of the Innovative Technique Award.

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Development of 3D Printing Technology for Construction Using Fiber Reinforced Cement Composites


Hiroki Ogura
SHIMIZU CORPORATION


Shinya Yamamoto
SHIMIZU CORPORATION


Hiroyuki Abe
SHIMIZU CORPORATION


Ryu Kikuchi
SHIMIZU CORPORATION


Reina Nakanishi
SHIMIZU CORPORATION

Reasons for the Award

In preparation for an era of shortage and aging of skilled construction workers, there is an urgent need to move away from conventional construction production. In concrete construction, although streamlining of construction by precasting components and other means is being promoted, a new concept of concrete construction technology is required to realize further efficiency.

This technology enables the printing of high-quality construction-scale components by ejecting and stacking materials from a digitally controlled nozzle. The material to be printed is a fiber-reinforced cement composite material developed by the company. By using this material, the company succeeded in overcoming the conventional problem of weak areas easily forming at the interface of each printed layer, and realized (1) modeling of laminates exceeding 2 m in height, (2) integration of the interface of each printed layer, and (3) high durability of the laminates. The fiber reinforcing effect makes the material very tough, and the 14 MPa bending strength without reinforcement is one of the few examples of such a feat in the world.

This technology has been highly evaluated for its ability to produce large-scale members with excellent mechanical properties and durability, with little variation in quality, and has been applied at several sites. In the case of the "Toyosu 6-chome Transportation Plaza Deck Expansion Project," the technology was applied to manufacture 24 laminated units with zero defect rate.

This technology not only contributes to improved productivity in construction, but also to realization of members with superior design, reduction of materials used through structural optimization, and reduction of environmental impact through formwork-free construction. As one of the new concrete construction technologies, this technology is highly innovative and socially useful, and is therefore worthy of the Innovative Technique Award.